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**RADAPPERTIZED MEATS FOR
AEROSPACE MEALS**

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**IRRADIATED FOOD PRODUCTS GROUP
RADIATION PRESERVATION OF FOOD DIVISION**

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June 1981

**UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT LABORATORIES
NATICK, MASSACHUSETTS 01760**



Food Engineering Laboratory

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<p>The purpose of this project was to produce radappertized meats for aerospace meals. This report documents the preparation, packaging, irradiation and testing of radappertized beefsteak, corned beef, ham, and smoked turkey. These meats were menu components on Apollo 17, Apollo-Soyuz, and Skylab III space flights.</p>		

PREFACE

The National Aeronautics and Space Administration (NASA) requested the Radiation Preservation of Food Division to supply NASA with nutritious, shelf stable, sterile, compact meat items for aerospace meals.

This report describes the preparation, packaging, radappertization and testing of beefsteak, corned beef, ham, and smoked turkey used as components of aerospace meals. The project was performed by the Irradiated Food Products Group, Radiation Preservation of Food Division, Food Engineering Laboratory, under Project 1L162724AH99DC. DOD Food Program Requirement MSR USA 5-1.

TABLE OF CONTENTS

	<u>Page</u>
Preface	2
List of Tables	4
Introduction	5
Materials and Methods	5
Results and Conclusion	10

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LIST OF TABLES

	<u>Page</u>
1. Test Results of Vacuum Packaged Irradiated Food Samples	10
2. Chemical Composition of Irradiated Food Samples	11
3. Sensory Scores of Irradiated Food Samples	11

RADAPPERTIZED MEATS FOR AEROSPACE MEALS

INTRODUCTION

The National Aeronautics and Space Administration (1972) requested the Radiation Preservation of Food Division to supply them with nutritious, stable without refrigeration, compact food items. Such items were needed for use during the first days of flight when the astronauts were busy with flight control and little time was available for food preparation.

Since meat sandwiches seemed likely to meet these requirements, experimental efforts were concentrated on ready-to-eat meat components. As various food items were produced, they were submitted to NASA for consideration. Of the numerous items presented, beefsteaks, corned beef, ham, and smoked turkey were accepted and used.

The meats were individual serving portions packaged in easy-to-open flexible pouches, sterilized with ionizing radiation. The pouch contents were sterile and shelf-stable for several years without refrigeration. Since the meats were cooked to an enzyme-inactivation temperatures, the products could either be eaten without heating or oven-heated in the pouch when hot foods were desired.

This report describes the procedures used in producing these products.

MATERIALS AND METHODS

Beefsteaks. Fresh, longissimus muscle (sirloin strip), USDA graded good or better, was trimmed of all surface fat and connective tissue. The trimmed strips were sliced into 15-mm steaks and seasoned (2 parts salt, 1 part white pepper, 1 part garlic salt) on each side.

The steaks were cooked on a charbroiler (270° C) for 3 minutes per side, then placed on a baking pan and heated to an internal temperature of 71° - 77° C (enzyme inactivation) in an electric oven (177° C). The cooked steaks were drained and chilled to 5° C or less. Steaks weighing 100 ± 20g were selected for each package.

Corned Beef. Fresh beef briskets, USDA graded good or better, were trimmed of all surface fat. The trimmed briskets were mechanically pumped with brine to a 15% level based on the weight of the meat. The brine consisted of:

Water	26.5 kg
Salt (sodium chloride)	3 kg
Sodium ascorbate	55 g
Sodium erythroate	55 g
Sodium nitrite	15 g
*Pickling spice mixture	340 g (dry)

The pumped briskets were stored at 3° C for 48 hours in plastic tubs. The briskets were cooked in boiling water (100° C) for one hour, then simmered until tender. The corned beef was drained, chilled to 5° C or less, then mechanically sliced (cross grain) into 3.0 ± 0.5 mm slices. Several slices, weighing 80 ± 10 g total, were selected for each package.

Ham. Fresh, raw pork ham, weighing 5 to 7 kg, and shankless, were skinned, deboned and trimmed so that all visible cartilage, ligaments, tendons, connective tissue, lymph glands, plus surface and internal fat were excluded. The hams were mechanically pumped with curing brine to a 12% level, then cut into 100-500 g chunks. An additional 3% brine was included so that the total brine contents equalled 15% based on the weight of the trimmed meat.

*A commercial spice mixture of coriander, mustard seed, fenugreek, dill, bay leaves, caraway, turmeric, chillies, etc. steeped in boiling water, then screened of insolubles.

The brine consisted of:

Water	25.5 kg
Sodium tripolyphosphate.	600 g
Salt (sodium chloride)	4.8 kg
Sodium ascorbate	55.0 g
Sodium erythrobate	55.0 g
Sodium nitrate	10.0 g
Sodium nitrite	5.0 g

The meat, with brine, was mixed (Hobart) for 15 minutes to a tacky consistency, then vacuum-mixed (Keebler) for an additional 20 minutes. The meat was stuffed into size 11 prestuck fibrous, regenerated cellulose casings, then tightly packed into stainless steel wire cages measuring 9 cm x 13 cm x 75 cm. Normally, 8 kg of meat are pressed in this size cage to produce rectangular hams. The caged meat was stored at 3° C for a minimum of 24 hours prior to smokehouse cooking.

The caged raw ham was smokehouse-cooked in accordance with the following schedule:

<u>Time</u>	<u>Dry bulb temperature</u>	<u>Wet bulb temperature</u>
1 hr without smoke	66° C	49° C
1 hr with smoke	66° C	49° C
1 " " "	71° C	54° C
3 " " "	77° C	57° C
- - " "	82° C	66° C

Cooked at 82° C until the meat internal temperature was 73° C (enzyme inactivation) and then continued at 77° C (wet bulb control off) until the weight of the product was 95 to 98% of the meat weight prior to addition of curing brine.

After cooking, the hams were chilled to 5° C or less, casings removed, and mechanically sliced into 6.3 ± 1 mm slices. Two slices of ham, weighing 90 ± 10 g total, were selected for each package.

Smoked Turkey. The raw turkey, USDA Grade A, was either whole weighing 8 to 11 kg or bone-in breasts weighing 6 to 9 kg. The raw material could be fresh or frozen, but if frozen, was thawed prior to processing. Only breast meat was used in the final product. The turkey meat was pumped with brine to a 5% level based on the total weight of the meat. The brine consisted of:

Water	25	kg
Sodium tripolyphosphate	750	kg
Salt (sodium chloride)	2	kg
Sodium ascorbate	112	g
Sodium erythrobate	112	g
Sodium nitrite	29.4	g

The pumped turkey was held overnight in a cover brine at 3° C before cooking. The turkey meat was smokehouse-cooked in accordance with the following schedule:

<u>Time</u>	<u>Dry bulb temperature</u>	<u>Wet bulb temperature</u>
1 hr with smoke	66° C	49° C
2 hrs " "	77° C	66° C
1 hr " "	82° C	66° C

The turkey meat was loosely covered with aluminum foil to prevent burning, then oven roasted (190° C) to an internal temperature of 85° to 90° C. The cooked turkey was chilled to 5° C or less and the breast meat mechanically sliced into 3.0 ± 0.5 mm slices. Several slices of the turkey meat, weighing 90 ± 10 g total, were selected for each package.

Packaging. After slicing, the products were placed in flexible pouches. The pouch measured 120 mm x 191 mm \pm 2 mm with "V" notches cut into the side seams to facilitate opening. The pouch was constructed from multiple layer laminate material. The outer layer was polyiminocaproyl (Nylon 6) (0.025mm), the middle layer was 1145 alloy aluminum foil (0.009 mm), and the inside layer was the chemically bonded laminate of polyethylene terephthalate and medium density polyethylene (0.062 mm) with the polyethylene as the food contactant. The filled pouches were sealed under vacuum (7.2 kPa, STP) with impulse sealing equipment (Multivac Electronic). A go-no-go dosimeter was attached to each pouch to indicate by color change exposure to radiation.

Radiation Sterilization. The products were irradiated utilizing either the U.S. Army Natick R&D Laboratories' Cobalt- 60 source (gamma ray) or the linear accelerator (electron beam) at 27 to 43-kGy dose levels as listed below. Prior to the irradiation treatment, the pouches were frozen to $-30^{\circ}\text{C} \pm 10^{\circ}\text{C}$.

<u>Food</u>	<u>Irrad Temp.</u>	<u>Irrad Dose</u>
Beefsteak	$-30 \pm 10^{\circ}\text{C}$	41 - 43 kGy
Corned Beef	$-30 \pm 10^{\circ}\text{C}$	27 - 29 kGy
Ham	$-30 \pm 10^{\circ}\text{C}$	32 - 35 kGy
Smoked Turkey	$-30 \pm 10^{\circ}\text{C}$	37 - 43 kGy

Evaluation. Randomly selected filled pouches were tested for:

- a. Pouch seal strength, seal integrity under vacuum, and volume of residual gases after irradiation;
- b. Sterility;
- c. Chemical composition;
- d. Sensory characteristics (color, odor, flavor, and texture).

All testing, except for the sensory evaluations, were done in compliance with the requirements listed in:

Space Food Prototype
Production Guide No. 60-B
26 March 1979
U.S. Army Natick R&D Laboratories
Natick, MA 01760

The sensory characteristics were scored by a trained technological panel of 10 to 12 members who rated the samples using a scale of 1 (extremely poor) to 9 (excellent) with a score of 5 considered acceptable.

RESULTS AND CONCLUSION:

The results of the pouch seal tests and residual gases showed all pouches were acceptable and packaging vacuums were satisfactory (Table 1).

TABLE 1 - Test* results of vacuum-packaged, irradiated food samples

	<u>Seal strength test</u>	<u>Seal integrity under vacuum</u>	<u>Volume of residual gases</u>
Beefsteak	> 2 kg	No failure noted	< 1 cc
Corned beef	> 2 kg	No failure noted	< 1 cc
Ham	> 2 kg	No failure noted	< 1 cc
Smoked turkey	< 2 kg	No failure noted	< 1 cc

The radappertized meat pouches were considered sterile as none showed swelling after incubation and no outgrowth was noted when the pouch contents were cultured.

The food's chemical composition were in the normal value range (Table 2).

*Space Food Prototype Production Guide No. 60-B, 26 March 1979
U.S. Army Natick R&D Laboratories, Natick, MA 01760

TABLE 2 - Chemical composition of irradiated food samples

	Moisture %	Protein %	Fat %	Nitrogen %	Calcium mg/100 g	Phosphorus mg/100 g	Iron mg/100g	Sodium mg/100 g	Potassium mg/100 g	Magnesium mg/100 g	Chloride as NaCl %	Ash %	ph	Calories per 100 g
Beefsteaks	55.5	28.9	13.7	4.6	9.3	134	3.4	149	365	24.7	0.6	1.4	6.0	247
Corned beef	60.2	32.1	5.1	5.2	12.4	149	2.8	600	108	16.5	1.7	2.0	6.0	183
Ham	67.2	21.4	6.7	3.4	7.1	271	1.4	1224	381	20.7	2.9	4.2	6.1	148
Smoked turkey	65.3	28.7	3.4	4.6	15.3	240	0.4	809	315	26.9	2.0	2.8	6.2	153

All sensory characteristics scored by the technical panel were in the acceptable range (Table 3).

TABLE 3 - Sensory scores of irradiated food samples

	Color	Odor	Flavor	Texture
Beefsteak	7.3 \pm .67	7.1 \pm .56	6.7 \pm .82	6.0 \pm .81
Corned beef	7.5 \pm .70	7.2 \pm .78	7.3 \pm .67	7.0 \pm 1.24
Ham	7.8 \pm .59	7.0 \pm .99	7.2 \pm .89	7.4 \pm .72
Smoked turkey	6.7 \pm 1.25	6.3 \pm .94	6.4 \pm .96	6.7 \pm 1.15

Radappertized ham was eaten on the December 1972 Apollo 17 flight to the moon. The ham was consumed at three meals as sandwiches made with radurized bread. The bread had been manufactured using irradiated rye flour. The astronauts reported that the juicy, chewy ham and cheese on rye was one of space culinary delights. Radappertized ham and canned bread made from irradiated wheat flour were used as emergency back-up foods in Skylab III.

In response to a NASA request for foods for the Apollo-Soyuz test program, samples of ham, corned beef, beefsteak, and turkey slices were evaluated by Russian and American crewmen. These products were selected and were later eaten during the July 15-24, 1975 flight.